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Specification

Method and Device for Threading a Web

The invention relates to a method and device for threading a material web in accordance with the generic portion of Claims 1 and/or 17.

Devices of this type are used in printing presses for conveying the tail of a material web along the desired threading path through the printing press. This is necessary, for example, when threading for a new production, or is always necessary whenever a material web has ripped during the printing process such that the tail of the new material web cannot be pulled through in the way of a flying reel change. Moreover, in modern printing presses, it is possible for the material to be printed to be moved along different supply paths in order to achieve different printing results such that, in the case of a changeover, the new material web must be pulled along the appropriate threading path.

DE 94 15 859 U1 discloses a device for threading a material web into a treatment station in which the threading means, embodied as a belt, may be rewound from one winding roll at the intake point of the treatment station to a winding roll at the outlet from the treatment station. The two winding rolls have one drive each in one exemplary embodiment.

In one embodiment, DE 197 24 123 A1 discloses a noncontinuous threading means that may be wound back and forth between two spool bodies, each of which is driven.

A device for threading material webs in rotation printing presses is known from DE 22 41

127 A1 in which the threading means, which is embodied in the manner of a spring steel belt, may be conveyed through to the exit of the printing press along various threading paths, which may be repositioned by means of switch points. Here, the threading means is driven by a driving wheel that is fixed in place, that engages in a positive fit with the threading means, and that pushes the threading means through the printing press along its entire length.

EP 04 18 903 A2 discloses a device for threading a material web in which a threading means is driven by a motor that is regulated based on data measured during the threading process. The regulation process works to maintain a constant threading speed and/or engine speed.

DE 94 09 390 U1 discloses a device for threading a material web in which a threading means is driven by a multi-phase motor. A transport path that has already been covered by the threading means is detected by means of sensors.

Devices for threading a material web are known from WO 02/090 650 A2 in which a noncontinuous threading means is driven by a drive in the region of a delivery area for the material web. In a first variation, this drive is regulated with regard to its speed, which may optionally be correlated with an independently driven aggregate of the machine, and in the second variation it is regulated with regard to a torque.

The object of the invention is to create a method and a device for threading a material web.

This object is attained by the features of claims 1 and/or 17.

One advantage of the invention lies in the fact that the machine may be started up in a

faster and more secure manner after the threading process. Here, the threading process occurs in a manner that is very protective of the material, in spite of the possibility of high threading speeds.

In principle, the threading means may be embodied in a continuous fashion, i.e., as a closed, belt-shaped material, that may be conveyed over one driven roll in the region of a beginning of the threading path and one driven roll in the region of an end of the threading path.

However, it is advantageous for the threading means to be embodied in a noncontinuous fashion, with each of its ends being disposed on a spool body such that it may be wound from one spool body in the region of a beginning of the threading path to a spool body in the region of the end of the threading path. In so doing, however, both ends remain connected with their respective spool body.

According to one preferred embodiment, the threading means is driven by driving one spool body in the region of the beginning of the threading path and one in the region of the end. It is advantageous for these drives to be drivable in two rotational directions for winding and unwinding the threading means.

An adjustable electric motor is used to drive the spool body located on at least the end of the threading path such that the spool body may be driven in a regulated manner with various rotation speeds and/or engine speeds. Preferably, the drives of both spool bodies are embodied as being adjustable in terms of their engine speed and/or the existing torque. By appropriate measurement of the infeed speed of the threading means using measurement points or by detection of the winding or unwinding angle on the spool body, the infeed may be calculated and,

by regulating the electric motor, a constant supply speed can be adjusted for the threading means. By detecting the existing torque (e.g., electrical output), the existing torque may be determined and a certain torque may be maintained or a maximum torque may be monitored. Depending on the given requirements, the respective electric motor is then appropriately adjusted with regard to a speed (e.g., frequency) or an engine speed (output).

During the threading process in one particularly advantageous embodiment, the drive in the region of the end of the threading path (e.g., in the region of the superstructure) is operated with the speed or engine speed being regulated, while the drive in the region of the beginning of the threading path (e.g., in the region of the reel changer) is operated with regard to a torque, e.g., a constant retaining torque. In this manner, an even threading process is made possible and a particular tension of the web is guaranteed during the threading process. This process (regulation of speed and torque) prevents so-called "bags" from forming in the web path due to too low of a tension and/or a dancer roller located in the web path from being loaded with a too strongly deviating web tension. In the latter case, when the machine was started, for example, extremely high deviations from target values and therefore high amplitudes of regulating systems would occur. "Incorrect" web tensions in the startup phase (too high or too low due to "bag" formation) could then easily lead to web tears, or at least to an unnecessarily high amount of maculation.

In a further development, this sort of process and device are in an active connection to a machine controller and/or a web tension regulator provided for operation. In other words, simply by correctly threading the web during the original installation of the aggregates that influence web tension, e.g., the dancer rolls, it is possible to create a machine that is ready for operation.

In principle, a plurality of sensors is conceivable for measuring the supply speed of the threading means. A particularly simple construction results when the effective circumference of the spool body with which the threading means is unwound as well as the rotational speed of the spool body is measured or provided as a curve. The effective circumference of the spool body is understood as the value that results from adding the circumference of the spool body itself to the circumference of the layers of the threading means still wound thereon. By evaluating these two measured values, the linearly oriented feeding path and the time-dependent linearly oriented feeding speed of the threading means may be easily determined and, subsequently, by means of appropriate regulation, the rotational speed of the spool body may be regulated to a target value. It is also conceivable for a control curve in the underlying software to contain the corresponding dependence of the target rotational speed on the number of rotations that have occurred.

One exemplary embodiment of the invention is shown in the drawing and is described in greater detail in the following.

The drawing shows a printing press with a device for threading a material web in a schematically shown cross section.

In a web processing and/or finishing machine 01, for example, a printing press 01, for treating a web and/or material web, for example, for printing on a paper web, a device is provided for threading a tail of the web into the machine 01 by means of which a tail of the web may be conveyed from a beginning of the threading path to an end of the threading path. Optionally, either before or after this machine-fed path, a manual path may connect further through the machine.

By way of example, the printing press 01, which is shown only schematically in the drawing, has an aggregate 02 embodied as a printing unit 02, here with two double printing groups or four printing groups, as well as an aggregate 03 embodied as a reel changer 03 and a folding funnel 04. Connected to the folding funnel 04 is an aggregate 05 embodied as a folding apparatus 05 that continues to process the material web. In operation, the web, which is not shown, runs from the reel changer 03 through one or more printing units 02, optionally by way of a superstructure, which is not shown, having a longitudinal cutting device and a reversing deck, by way of the folding funnel 04. A device for threading the material web is provided in order to thread the web mechanically onto at least one section of this sort of path.

In an advantageous first embodiment, in a frontal region of the machine in which a web to be threaded may be connected to a threading means 06, referred to in the following as the receiving area, and in a rear region in which the threaded web is separated from the threading means 06, referred to in the following as the delivery area, the device has one spool body 07; 08 onto each of which the threading means 06 may be wound or unwound by said spool bodies.

In an embodiment that is not shown, the threading means 06 is continuous, i.e., embodied as a loop which, instead of being wound on spool bodies 07; 08, circulates in the receiving area and the delivery area of a transport reel or roller. It is preferable for these transport reels to be driven in the same manner as the spool bodies 07; 08, which are described in greater detail below, i.e., regulated or controlled by rotational speed or torque. In order to reduce slippage, they may work together with pressure rolls or rollers, for example.

The receiving area is preferably located in the vicinity of the reel changer 03 such that the

web may be guided by the threading means 06 directly after the unwinding of the reel.

Fundamentally, the delivery area may be disposed at any desired point of the web path up to and including behind the folding funnel 04. In the advantageous embodiment shown here, the delivery area and thus the spool body 07 is disposed after the (last) printing unit 02 through which the web passes, but before the folding funnel 04. If reversing rods are located in the superstructure, the delivery area may optionally be located even before these reversing rods if the guidance system for the threading means 06 and the web are not constructed for moving around the reversing rods.

However, it is advantageous for the entire web to be threaded in a straight line up to the folding funnel 04 and only after this web has been threaded for the blade to be placed in the superstructure and the new partial web to be pulled over the reversing rods. Here, the delivery area is located slightly before the entrance to the funnel.

In the exemplary embodiment shown, the spool body 07 is driven in the delivery area by means of a drive having a single motor 11, for example, an electric motor 11, in particular an alternating current motor that may be regulated at least with regard to its engine speed. In a simpler preferred embodiment, there is only one control by means of which the target value \dot{n}_{soil} for the engine speed or frequency of the motor 11 is simply impressed into a control loop without feedback. In an alternative embodiment, the motor 11 is controlled in that, using a provided target value, an internal control loop of the drive calculates a target value \dot{n}_{soil} for the engine speed or frequency, i.e., the winding and unwinding speed of the threading means 06 is ultimately calculated by taking the winding radius into account. Here, for example, an actual

value of a measured angle speed or the number of rotations per unit time of a component or a motor is sent back to a drive regulator, which is not shown.

The target value \dot{n}_{soll} for the engine speed and/or frequency that ultimately represents the threading speed is given to the motor 11 or its drive control by a control device 12. This control device 12 has, for example, a frequency converter 13 and a control and/or calculation unit 14, in particular a servo control unit 14, embodied as a Servo PLC 14, for example. With reference to a target value of a given threading speed v_{soll} , logic integrated into the Servo PLC 14 (or an additional logical component) then calculates the target frequency and supplies it to the motor 11 by way of the frequency converter 13. In a simple embodiment, the threading speed v_{soll} may be directly and manually provided to the control device 12, for example, by way of an input medium or a corresponding interface on the control device 12. In a preferred embodiment, the entry of the threading speed v_{soll} is made by way of a higher-level control device 16, for example, a machine control 16. This guarantees synchronization between the speed of movement of the threading means 06 and at least components or aggregates 02; 03; 05 of the printing press 01, which interact with the web to be threaded, for example, by coming into physical contact with it.

By way of example, the figure shows a rotary drive 17 for the printing unit 02 and/or a rotary drive 18 for the reel changer 03 and/or a rotary drive 20 of the folding apparatus 05 in signal connection to the machine control 16. The rotary drives 17; 18; 20 are preferably embodied to be mechanically independent from one another but are connected to one another electronically by way of the machine control 16. When a particular machine speed is entered, for example, a particular threading speed in the threading operation, the printing unit 02 and/or the

reel changer 03 (and, optionally, other aggregates) as well as the control device 12 of the device for threading the web receive speed-relevant target values that are correlated with each other and that guarantee synchronization of the speeds, for example, the unrolling speed at the reel changer 03 or the circumferential speed at the printing cylinder and the web speed.

The movement control of the subordinate drives 17; 18; 20 (target value input) preferably follows a conductivity value of a so-called electronic guide axis Φ . The position of the guide axis Φ may either be oriented on one of the aggregates 02; 03; 05 of the printing press 01, for example, the folding apparatus 05, and provide the input values to the remaining aggregates 02; 03, or the guide axis Φ may rotate freely – optionally depending on calibration on one of the aggregates 02; 03; 05, for example, the folding apparatus 05 – and, in subsequent operation, supply the positions to all aggregates 02; 03; 05. A winding speed of this rotating guide axis Φ then corresponds to a predetermined machine speed, for example, a setting for a “threading speed for automatic threading” or a setting to print with an engine speed or product output that may be predetermined. As a result, during the threading process, due to the machine control 16 (and/or the guide axis Φ), the movements of at least one moving aggregate 02; 03 that interacts with the web (e.g., the printing unit 02 and/or the reel changer 03) and the threading means 06 are synchronized. The target value input of the threading speed v_{sol} into the control device 12 is preferably aimed at a selected machine speed.

When the device is embodied with a threading means 06 that is to be wound and unwound and a drive to wind or unwind one or both spool bodies 07; 08, the changing winding radius must be taken into account when entering the target value \dot{n}_{sol} into the motor 11.

Although fundamentally, this radius may be detected on a continual basis by arranging at least one sensor on the spool body 07; 08, it is preferably calculated using the base diameter of one or both spool bodies d07; d08, the number of winding layers or rotations u_{0X} on one or both spool bodies d07; d08 and the thickness d06 of the threading means 06. If, with regard to a tension in the threading means 06 that must be maintained, a negligible lead must be provided in the engine speed n_v , this must be added in as well. A current target value \dot{n}_{soll} for an engine speed may, in principle, be calculated using the equation below

$$\dot{n}_{soll} = \frac{v_{soll}}{\pi * (d0X + (2 * d06 * u_{0X}))} + \dot{n}_v,$$

where 0X = 07 or 08 and where, depending on the location of the arrangement of a sensor 19, for example, a resolver 19, detecting the number of rotations or angular degrees that have been passed through, a transformation from one spool body 07; 08 to the other must occur.

In the figure, in order to count the number of rotations, the resolver 19 is shown in solid lines in the region of the spool body 07 and in dashed lines in the region of the spool body 08.

From the target value for the threading speed v_{soll} , the base diameter of one or both spool bodies 07; 08, the number of winding layers or rotations u_{0X} on one or both spool bodies d07; d08 and the thickness d06 of the threading means 06, a corresponding signal for the motor 11 for keeping the threading speed constant is then generated in the control and/or calculation unit 14

and in the frequency converter 13 and sent to the motor. In threading operation, the motor 11 in the delivery area is thus regulated by its engine speed to a constant threading speed v . The expression $d0X + (2 \cdot d06 \cdot u_{0X})$ then represents a current, calculated diameter $D0X$ ($D07$, $D08$) after u_{0X} rotations.

In contrast, a motor 21, for example, an electric motor 21, in particular an asynchronous motor 21, driving the spool body 08 in the receiving area is driven during the threading operation at least in a torque-limiting manner. This is accomplished using the servo control of the control and/or calculation unit 14. The logic mentioned above for calculating a target frequency for the motor 11 as well as the servo control for the motor 21 may also be embodied in separate components.

In an advantageous operational mode, a desired tightening of the belt in the threading operation occurs by actuating the motor 21 in the receiving area with a constant retaining momentum; here, in principle, the motor 21 runs in the rotational direction opposite the unwinding direction. However, it becomes effectively forced into the rotational direction for unwinding by means of the stronger motor 11.

In the threading operation, the threading means 06 is thus pulled by the motor 11 and the spool body 07 in a circumferential speed-controlled manner from the reel changer 03 to the delivery area (e.g., to the folding funnel 04), with the motor 11 being fed by the frequency converter 13 which in turn receives a calculated target value \dot{n}_{sol} for the frequency from the control and/or calculation unit 14 that depends on the current machine speed (or the target value of the threading speed v_{sol}) and the calculated diameter $D07$; $D08$ of the spool body 07; 08 used

for calculation. The motor 21 in the receiving area (e.g., near the reel changer 03) is actuated by the control and/or calculation unit 14. In the threading mode, for example, it receives a low offset engine speed in the direction opposite the unwinding direction. For example, by adjusting a target tension value $Z_{\text{soll,e}}$ for the threading process by way of an input device to the drive, the torque may be limited. The motor 21 is "overtaken" by the stronger, engine speed-controlled motor 11 and thus provides the desired belt tension.

When rewinding, the motor 11 runs, for example, with an adjustable rewinding speed (e.g., $v = 26 \text{ m/min}$) and the motor 21 in the receiving area runs at an increased speed and a constant torque in order to produce the belt tension. In rewinding operation, the motor 11 receives its target frequency value, i.e., the target value \dot{n}_{soll} , corresponding to the currently calculated diameter D07; D08 of the spool bodies 07; 08 in the opposite direction. The motor 21 receives an adjustable speed evaluated with a fixed diameter, e.g., a diameter of 220 mm for the empty drum. In addition, as in the threading process, it is preferable for an offset engine speed to be added in order to ensure a constant lead on the motor 11 and its spool body 07. By a constant lead of the spool body 08 and an adjustable target tension value $Z_{\text{soll,r}}$ for the rewinding process, the desired belt tension is built up in rewinding operation.

Maintaining a constant threading speed and, in particular, maintaining particular torques when threading allows the web to be threaded in a manner such that the web and the aggregates that influence the web tension reach a state that already approximates the conditions required for starting the machine 01. This is shown in the figure by the example of an implied dancer roller 22 circumscribed by the threading means. When the machine 01, which is embodied as a

printing press 01, is in operation, the dancer roller 22 corrects an existing web tension with regard to a selectable, constant web tension. This tension may, for example, be provided and regulated by a web tension regulator (which here is integrated into the machine control 16).

Once the target value has been appropriately adjusted during the threading process and the torque on the threading means 06 has been maintained, threading is now possible without bag formation and/or without an undesired deflection of the dancer roller 22 occurring. This means that the threading process already occurs with approximately correct path lengths and tensions, so that when the machine 01 is started up later, the danger of web tears or protracted fluctuations in regulation are reduced. In a further development of the invention, a regulation of the web tension has already been activated during the threading process.

List of Reference Characters

01	Machine, printing press
02	Printing unit, aggregate
03	Reel changer, aggregate
04	Folding funnel
05	Folding apparatus, aggregate
06	Threading means
07	Spool body
08	Spool body
09	--
10	--
11	Motor, electric motor, alternating current motor
12	Control device
13	Frequency converter
14	Control and/or calculation unit, servo control unit, Servo PLC
15	--
16	Control unit, higher-level; machine control
17	Drive
18	Drive
19	Sensor, resolver

- 19' Sensor, resolver
- 20 Drive
- 21 Motor, electric motor, asynchronous motor
- 22 Dancer roller

\dot{n}_{soll} Target value

v_{soll} Threading speed

Φ Guide axis, electronic